FUEL CELL ENGINEERING

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Fuel Cells—New Energy Systems

Fuel Cells:

chemical batteries operating on hydrogen and air, efficient and long lasting—direct energy conversion to electricity.

Fuel Cells for Transportation:

efficient (less CO2/mile) and clean (ULEV or lower)

Fuel Cells Technology:

PEM fuel cell systems under development globally; major DOE emphasis for future, clean transportation.

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Fuel Cell Engineering Team Assets

- Staff:
  - 30-year combined experience in fuel cell technology
- Laboratories:
  - Hydrogen-certified testing environment for thorough evaluation of fuel processing, fuel cell stack and system performance; fully automated
- Modeling:
  - Theoretical basis for testing and evaluation; many unique codes
- Reputation:
  - Long term history of success

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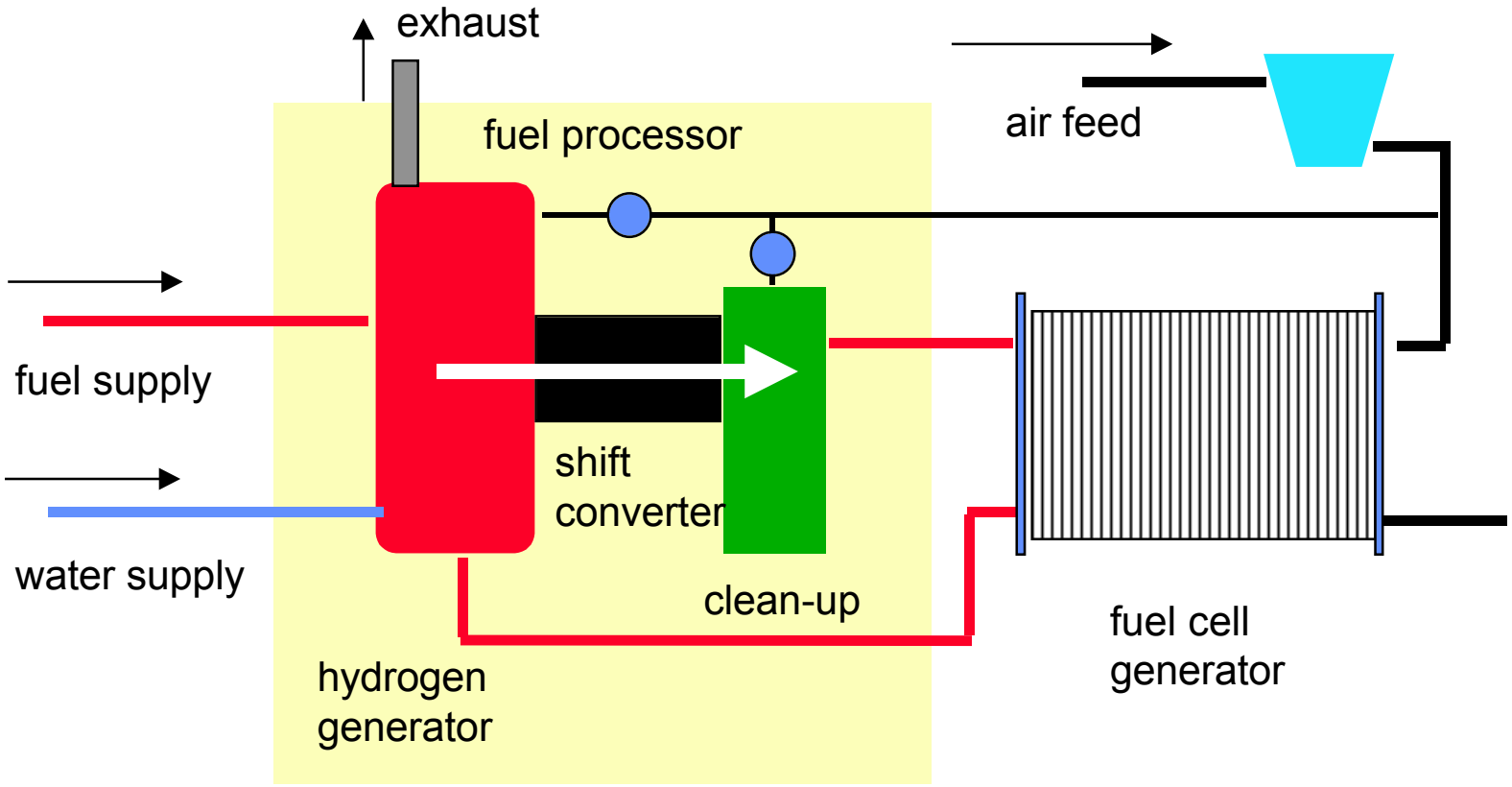
On-Board Fuel Processing



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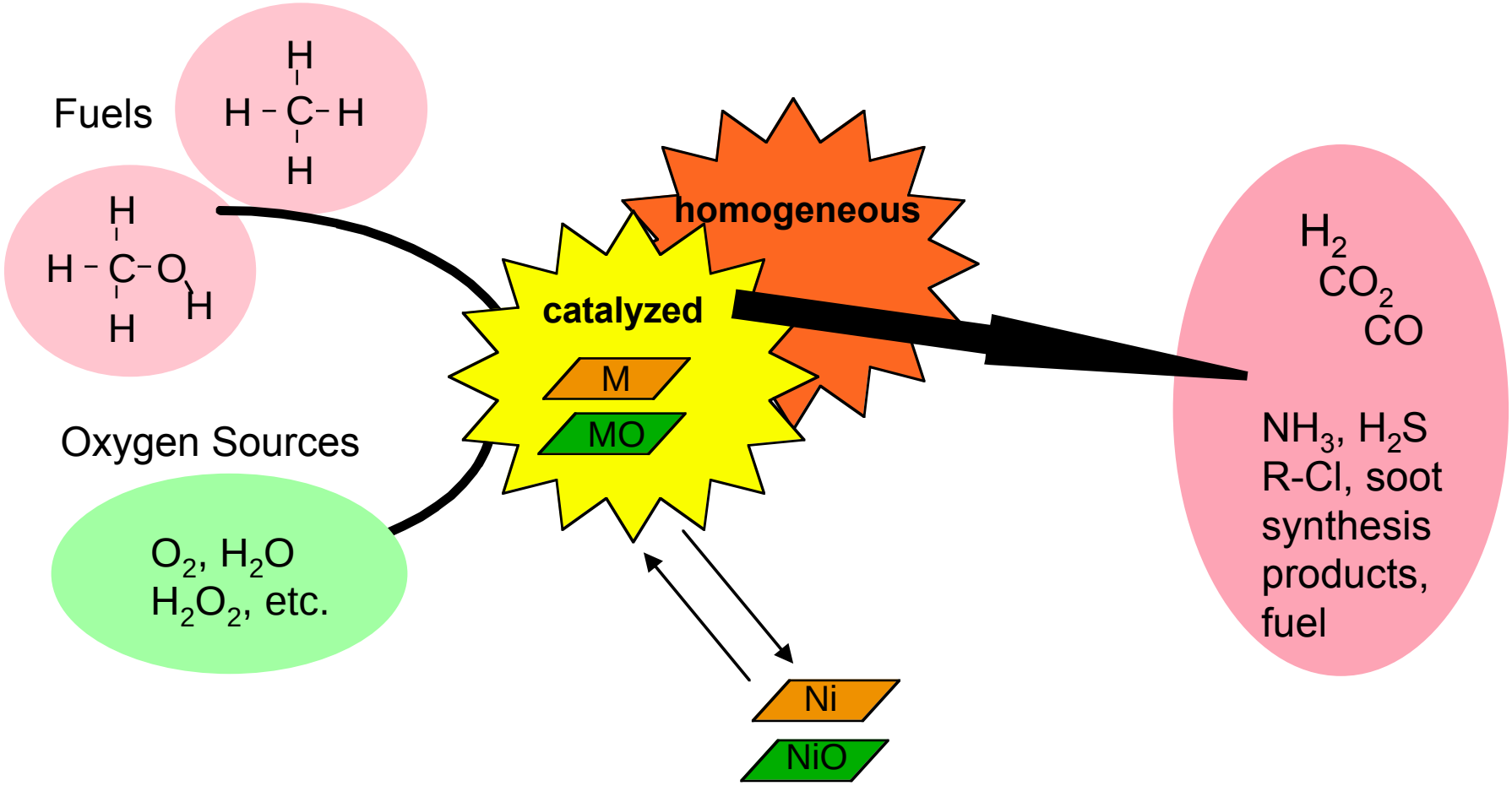
Fuel Processing: Oxygen Exchange Reactions



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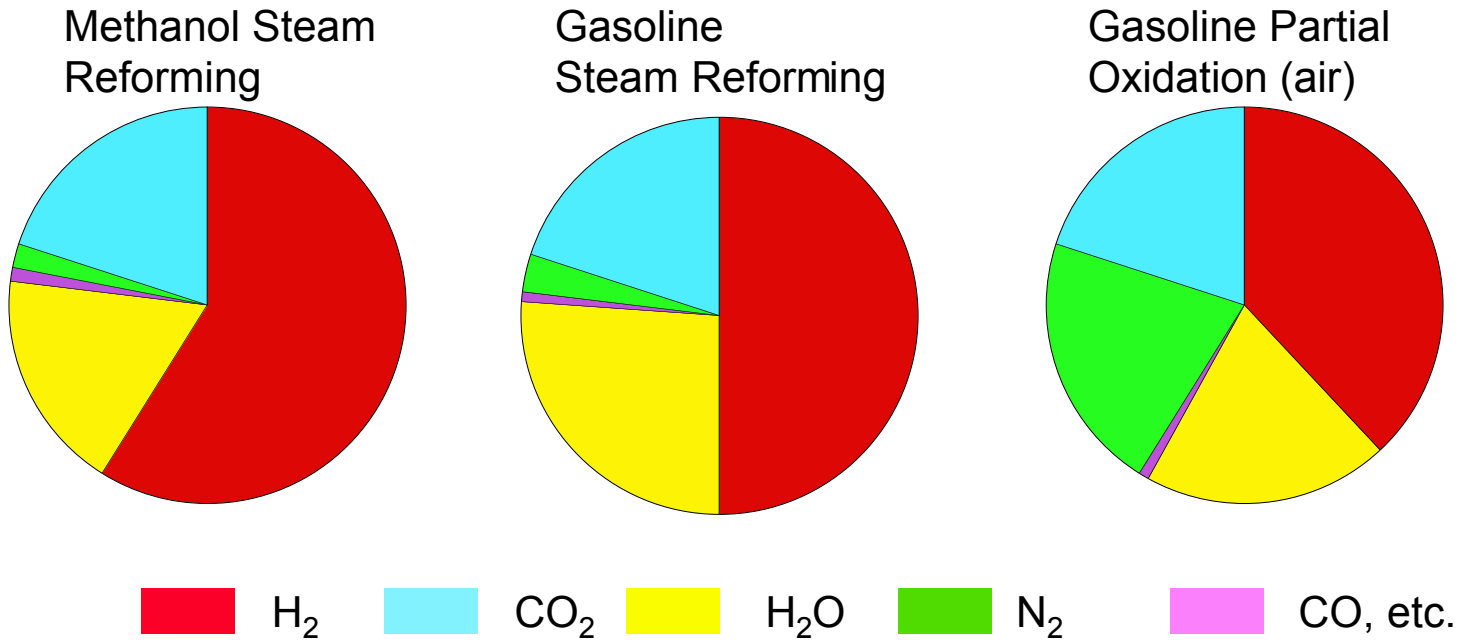
Goal: Anode Feed Stream for PEM System

- Achieve High Stack Voltage (increase system efficiency)
- Achieve High Current Density (reduce size and cost)
- Achieve High Hydrogen Utilization (increase efficiency)



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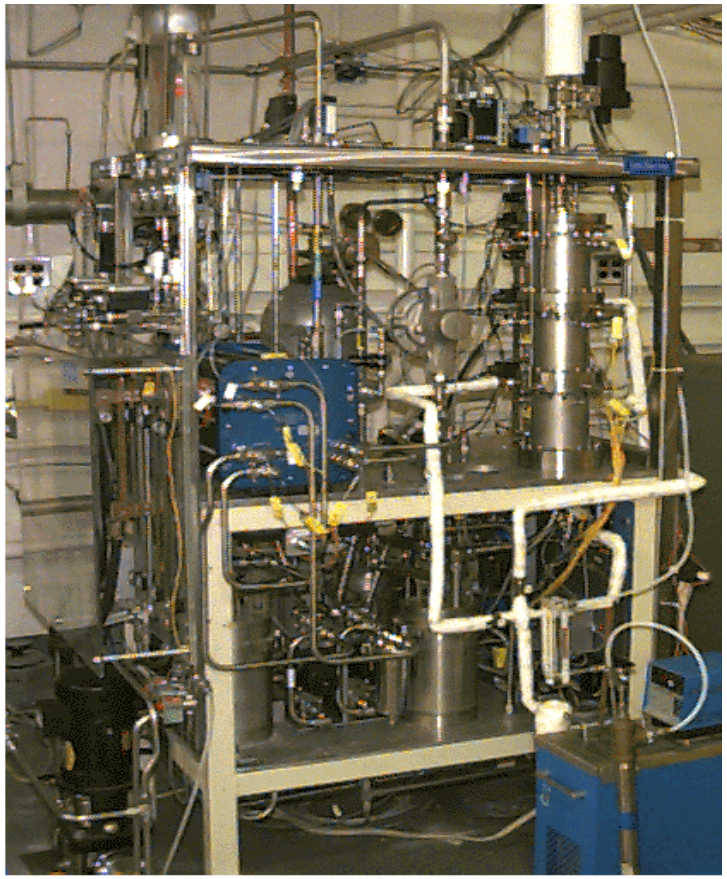
LANL 25-kW **PR**eferential **OX**idation (PROX)



- Staged PROX catalytic reactor with compact heat exchange and flow control elements (unique LANL design)
- Operates on autothermal reformer fuels (>2% CO)
- Controls permit low CO (< 20 ppm) with minimum hydrogen utilization
- Tested with A.D. Little multifuel reformer (October 1997)

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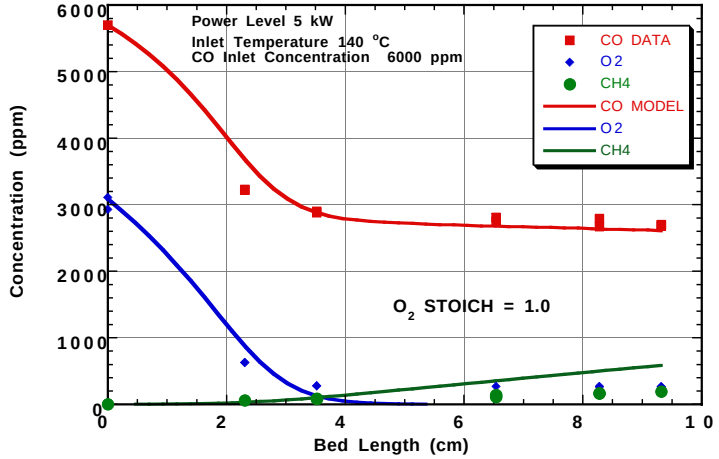
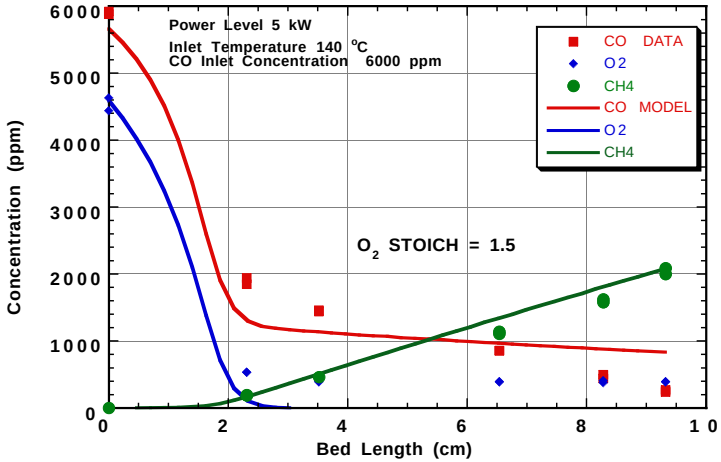
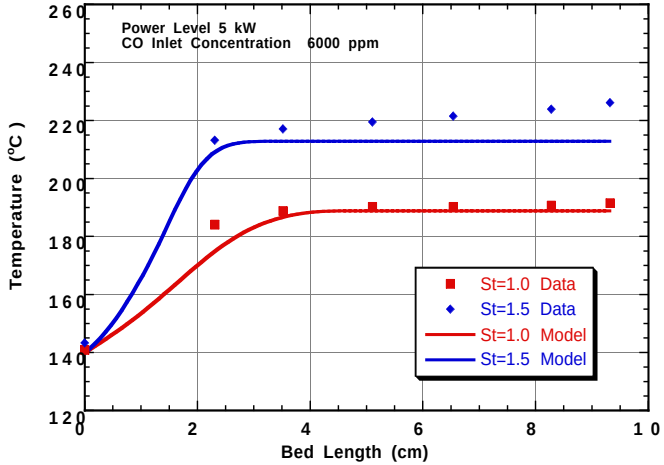
In-Situ Measurements





Data show temperature and concentration profiles through a 10-cm reactor length. Results are for for two different stoichiometric values, 1.0 and 1.5, starting with a 8,000 ppm CO inlet.



The LANL design combines oxidation with methanation to achieve stable CO control

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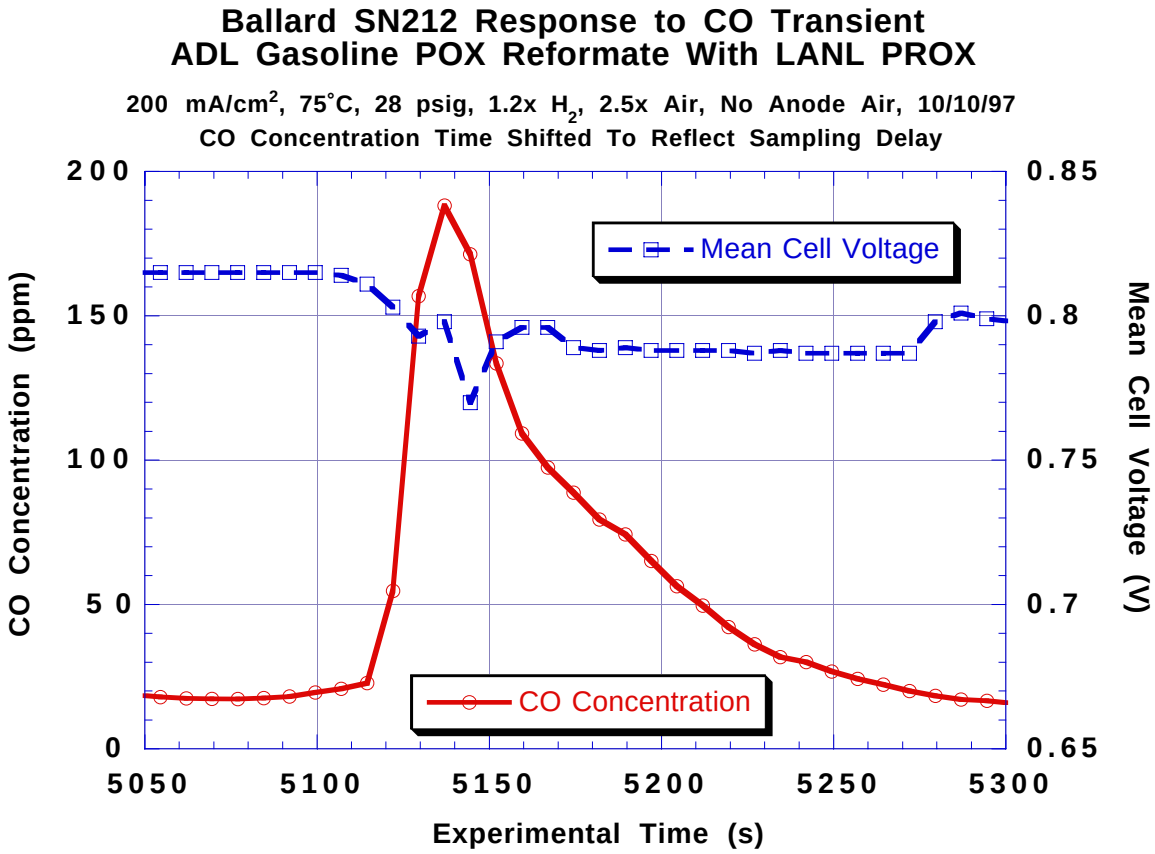
System Performance During Transient



LANL PROX operated through large CO excursion, keeping PEM stack operational

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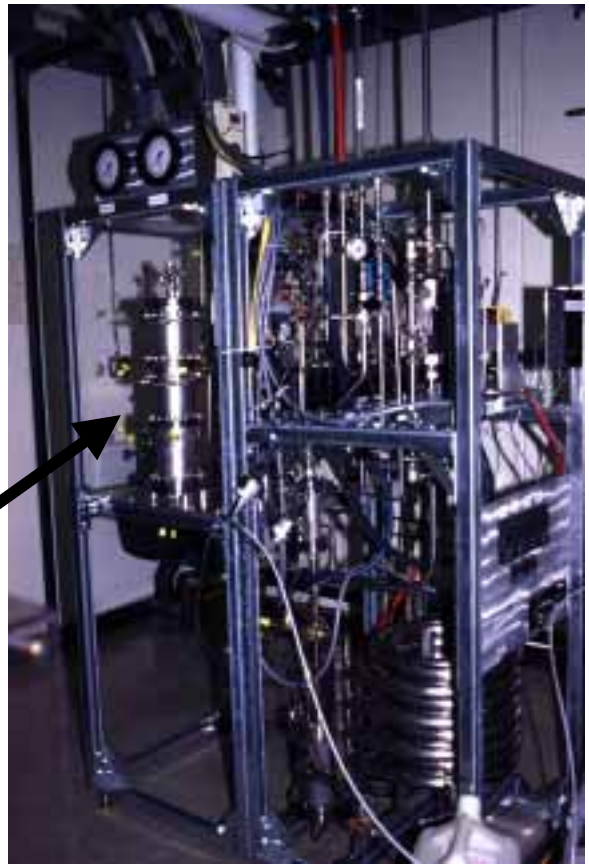
New PROX for Transportation Systems



Test hardware with PROX installed

- 50-kW System Hardware—processes up to 140 kW hydrogen
- Designed for transient operation
- Scale-up from proven 10-kW design
- FY98 deliverable

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Industrial Partnering

A. D. Little, Inc.: PROX development, partnership on new fuel processing concepts for hydrogen generation; hardware acquired.

Hydrogen Burner Technology.: Cooperative program using HBT hydrogen generators with LANL PROX for automotive applications.

Energy Partners: Supplying new PROX design for distributed generation systems.

Analytic Power: Cooperative program on anode optimization, coupled to PEM stack design.

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New Emphasis on Fuels Technology

Diesel Emissions: NOx, particulates (< 5 μ) troublesome; sulfur poisons emission control surfaces

Partnership for a New Generation of Fuel (PNGF) : new effort between Government and Industry to identify and develop future fuel

Concept: low sulfur, optimized fuel for both SULEV internal combustion engines and fuel cell engines.

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Next Steps

PROX Commercialization: working with partners, lead development of compact, reliable devices.

Hydrogen Generators: acquire two hydrogen generators (50-kW), and study transients, controls, catalysts and thermal management in partnership with suppliers.

Energy Storage: work on regenerative fuel cell systems for distributed energy storage.